MULTIMEDIA UNIVERSITY

STUDENT ID NO

MULTIMEDIA UNIVERSITY

FINAL EXAMINATION

TRIMESTER 2, 2017/2018

DET5068 – ANALOG ELECTRONICS 1
(Diploma in Electronic Engineering)

13 MARCH 2018
2:30 PM – 4:30 PM
(2 HOURS)

INSTRUCTIONS TO STUDENT

1. This question paper consists of **11** pages (**5** pages with **5** questions and **6** pages for appendix).
2. Answer **ALL** questions. All necessary working steps must be shown.
3. Write all your answers in the answer booklet provided.

QUESTION 1 [20 Marks]

a) Materials on Earth can be classified into 3 broad categories which are conductor, semiconductor and insulator. Thus, define each of the terms, explain their electron valence characteristics and gives 2 examples for each of the material categories.

(6 marks)

b) Estimate the force of attraction, $F_a \propto \frac{1}{d}$ and energy of electron, $E \propto d$ relationship for electron, e_1 and electron, e_2 with calculation base on the information below. State which electron have the higher possibility of escaping the valence band into the conduction band.

(i) Electron, e_1 has $d_1 = 2\times10^{-20}\,m$ and electron, e_2 has $d_2 = 4\times10^{-20}\,m$

(7 marks)

(ii) Electron, e_1 has $d_1 = 3\times10^{-25}\,m$ and electron, e_2 has $d_2 = 5\times10^{-25}\,m$

(7 marks)

Continued…

QUESTION 2 [20 Marks]

a)

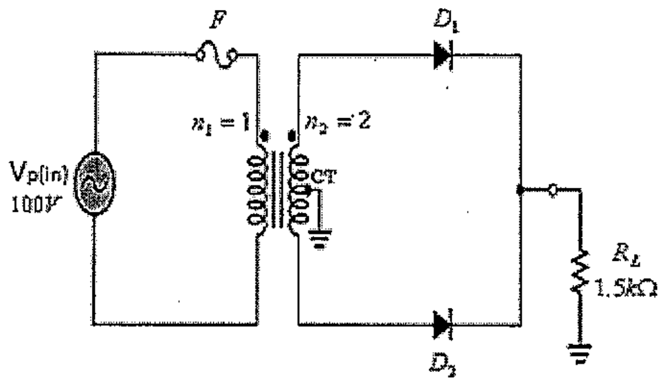

Figure 1(a)

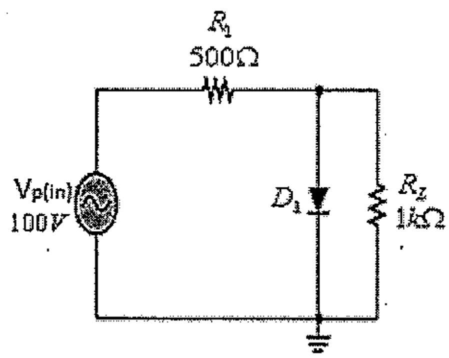

Figure 1(b)

Figure 1(a) and Figure 1(b) shows 2 types of diode application. Calculate the output voltage for each of the application using the given values.

(10 marks)

b) Draw the voltage-current characteristic curve of a normal diode and a Zener diode. Compare and state the difference between both voltage-current characteristic curve.

(10 marks)

Continued...

QUESTION 3 [20 Marks]

(a) A certain BJT has base current, $I_B = 50\mu A$ and collector current, $I_C = 5.66mA$.
Determine the following:

(i) DC beta, β_{DC}
(ii) emitter current, I_E
(iii) DC alpha, α_{DC}

(6 marks)

(b)

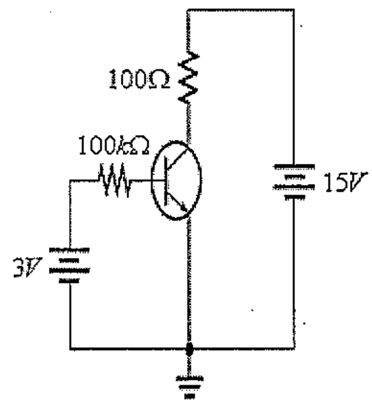

Figure 2

Figure 2 shows a transistor circuit bias. Determine the followings, if $\beta_{DC} = 200$.

(i) I_B (5 marks)

(ii) I_C (1 mark)

(iii) I_E (3 marks)

(iv) V_{CE} (2 marks)

(v) V_{BE} (1 mark)

(vi) V_{CB} (2 marks)

Continued...

QUESTION 4 [20 Marks]

An emitter bias circuit for BJT is having the following parameters: $R_C = 4.2k\Omega, R_B = 55k\Omega$, $R_E = 9.5k\Omega$, $V_{CC} = 20V$, $V_{EE} = -20V$ and $\beta_{DC} = 130$. Based on the information given:

(a) Sketch the circuit diagram

(5 marks)

(b) Evaluate the Q-point of the circuit.

(15 marks)

Continued...

QUESTION 5 [20 Marks]

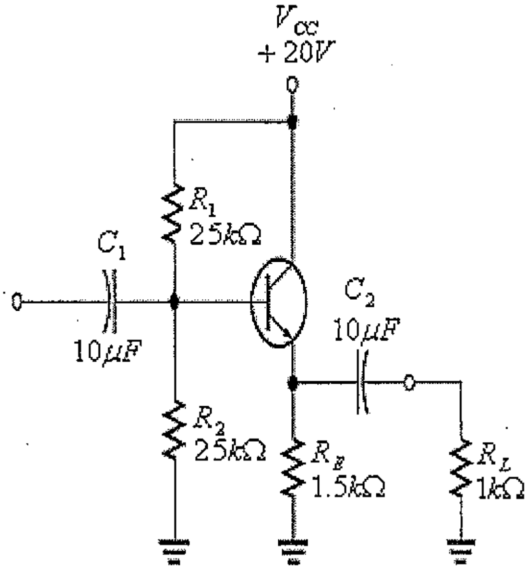

Figure 3

Figure 3 shows a certain type of BJT amplifier. Given that $\beta_{ac} = 90$ and $V_{in} = 1.5mVrms$.

(a) Identify the amplifier (1 mark)

(b) Calculate $R_{in(tot)}$ (7 marks)

(c) Calculate A_v (1 mark)

(d) Calculate A_i (10 marks)

(e) Calculate A_p (1 mark)

End of Page.

FORMULAE LIST

BJT BIAS	
TERMS	**FORMULAE**
DC load line equation	$I_C = -\frac{1}{R_C}V_{CE} + \frac{V_{CC}}{R_C}$
Voltage divider-bias:	
DC collector and emitter current	$I_C \cong I_E = \frac{V_E}{R_E}$
DC base voltage	$V_B = \frac{R_2 // R_{IN(BASE)}}{R_1 + \left(R_2 // R_{IN(BASE)}\right)} \times V_{CC}$ $V_B = \frac{R_2}{R_1 + R_2} \times V_{CC}$ if, $R_{IN(BASE)} >> R_2$
DC collector voltage	$V_C = V_{CC} - I_C R_C$
DC collector-to-emitter voltage	$V_{CE} = V_{CC} - I_C\left(R_C + R_E\right)$
DC emitter voltage	$V_E = V_B - V_{BE}$
DC input resistance at the base	$R_{IN(BASE)} = \beta_{DC} R_E$
DC total resistance	$R_T = R_2 // \beta_{DC} R_E$
Base bias:	
DC base current	$I_B = \frac{V_{CC} - V_{BE}}{R_B}$

DC collector current	$I_C = \frac{\beta_{DC}(V_{CC} - V_{BE})}{R_B}$
DC collector-to-emitter voltage	$V_{CE} = V_{CC} - I_C R_C$
Collector-feedback bias:	
DC base current	$I_B = \frac{V_C - V_{BE}}{R_B}$
DC collector current	$I_C = \frac{V_{CC} - V_{BE}}{\frac{R_B}{\beta_{DC}} + R_C}$
DC collector-to-emitter voltage	$V_{CE} = V_{CC} - I_C R_C$
Emitter bias:	
DC base current	$I_B \cong \frac{I_E}{\beta_{DC}}$
DC collector current	$I_C \cong \frac{-V_{EE} - V_{BE}}{\frac{R_B}{\beta_{DC}} + R_E}$
DC emitter current	$I_E = \frac{-V_{EE} - V_{BE}}{\frac{R_B}{\beta_{DC}} + R_E}$
DC base voltage	$V_B = V_E + V_{BE}$
DC collector voltage	$V_C = V_{CC} - I_C R_C$
DC collector-to-emitter voltage	$V_{CE} = V_C - V_E$

DC emitter voltage	$V_E = V_{EE} + I_E R_E$
BJT AMPLIFIERS	
TERMS	**FORMULAE**
r **Parameters:**	
ac base resistance	$r_b' = h_{ie} - \frac{h_{re}(h_{fe}+1)}{h_{oe}}$
ac collector resistance	$r_c' = \frac{h_{re}+1}{h_{oe}}$
ac emitter resistance	$r_e' = \frac{h_{re}}{h_{oe}}$
Common-base amplifier:	
DC emitter current	$I_E = \frac{V_E}{R_E}$
DC base voltage	$V_B = \frac{R_2}{R_1 + R_2} \times V_{CC}$
DC emitter voltage	$V_E = V_B - V_{BE}$
ac output voltage	$V_{out} = V_c$
ac input voltage	$V_{in} = V_e$
ac resistance at emitter	$R_{in(emitter)} \cong r_e'$
ac output resistance	$R_{out} \cong R_C$

Current gain	$A_i \cong 1$
Voltage gain	$A_v \cong \frac{R_c}{r_e'}$
Power gain	$A_p = A_v$
Common-collector amplifier:	
ac input current	$I_{in} = \frac{V_{in}}{R_{in(tot)}}$
ac emitter current	$I_e = \frac{V_e}{R_e}$
ac emitter voltage	$V_e = A_v V_b$
ac input resistance at base	$R_{in(base)} \cong \beta_{ac} R_e$
ac total input resistance	$R_{in(tot)} = R_1 \,//\, R_2 \,//\, R_{in(base)}$
ac output resistance	$R_{out} \cong \left(\frac{R_s}{\beta_{ac}}\right) // R_E$
Current gain	$A_i = \frac{I_e}{I_{in}}$
Voltage gain	$A_v \cong 1$
Power gain	$A_p = A_i$

Common-emitter amplifier:	
DC collector current	$I_C \cong I_E$
DC base voltage	$V_B = \frac{R_2}{R_1 + R_2} \times V_{CC}$
DC collector voltage	$V_C = V_{CC} - I_C R_C$
DC collector-to-emitter voltage	$V_{CE} = V_C - V_E$
DC emitter current	$I_E = \frac{V_E}{R_E}$
DC emitter voltage	$V_E = V_B - V_{BE}$
DC input resistance at base	$R_{IN(BASE)} = \beta_{DC} R_E$
ac base current	$I_b \cong \frac{I_e}{\beta_{ac}}$
ac base voltage	$V_b = \frac{R_{in(tot)}}{R_s + R_{in(tot)}} \times V_s$ $= I_e r_e'$
ac collector voltage	$V_c = A_v' V_x$
ac total current signal	$I_s = \frac{V_s}{R_{in(tot)} + R_s}$

ac input resistance at base	$R_{in(base)} = \beta_{ac} r'_e$
ac total input resistance	$R_{in(tot)} = R_1 // R_2 // R_{in(base)}$
ac output resistance	$R_{out} \cong R_C$
Current gain	$A_i = \dfrac{I_c}{I_s}$
Voltage gain	$A_v = \dfrac{R_C}{r_e'}$ if C_2 exists $A_v = \dfrac{R_C}{r_e' + R_E}$ if C_2 does not exist
Overall voltage gain	$A_v' = Attenuation \times A_v$
Power gain	$A_p = A_v' A_i$